53. IWK

Internationales Wissenschaftliches Kolloquium
International Scientific Colloquium

Faculty of
Mechanical Engineering

PROSPECTS IN MECHANICAL ENGINEERING

8 - 12 September 2008

www.tu-ilmenau.de

TECHNISCHE UNIVERSITÄT
ILMENAU

Published by
Impressum

Publisher Herausgeber	Der Rektor der Technischen Universität Ilmenau Univ.-Prof. Dr. rer. nat. habil. Dr. h. c. Prof. h. c. Peter Scharff
Editor Redaktion	Referat Marketing und Studentische Angelegenheiten Andrea Schneider Fakultät für Maschinenbau Univ.-Prof. Dr.-Ing. habil. Peter Kurz, Univ.-Prof. Dr.-Ing. habil. Rainer Grünwald, Univ.-Prof. Dr.-Ing. habil. Prof. h. c. Dr. h. c. mult. Gerd Jäger, Dr.-Ing Beate Schlütter, Dipl.-Ing. Silke Stauche
Editorial Deadline Redaktionsschluss	17. August 2008
Publishing House Verlag	Verlag ISLE, Betriebsstätte des ISLE e.V. Werner-von-Siemens-Str. 16, 98693 Ilmenau

CD-ROM-Version:

Implementation Realisierung	Technische Universität Ilmenau Christian Weigel, Helge Drumm
Production Herstellung	CDA Datenträger Albrechts GmbH, 98529 Suhl/Albrechts

ISBN: 978-3-938843-40-6 (CD-ROM-Version)

Online-Version:

Implementation Realisierung	Universitätsbibliothek Ilmenau ilmedia Postfach 10 05 65 98684 Ilmenau

Home / Index:
http://www.db-thueringen.de/servlets/DocumentServlet?id=17534

53rd Internationales Wissenschaftliches Kolloquium
Technische Universität Ilmenau
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InspiRat - Structure and Design of the Nature Inspired Climbing Robot RatNic

MOTIVATION

InspiRat is the acronym for a project aiming for the realization of small biologically inspired climbing machines. It is realized by partner groups from Technische Universität Ilmenau, Friedrich-Schiller-Universität Jena and Max-Planck-Institut Stuttgart in cooperation with TETRA GmbH Ilmenau.

Importance of automatic inspection is increasing. In buildings cables and pipes have to be inspected periodically to prevent or to detect damages. In old buildings infrastructure has grown over many years. Often maps, showing the exact course of supply lines, do not exist.

The main idea is to build robots, which can move along linear structures (cables and pipes). Challenges are the high locomotion ability in an unstructured environment and to minimize the energy consumption.

To realize a climbing robot system for inspection, nature is a rich source of ideas. In this case the technical design is inspired by locomotion principles of small vertebrates, like chameleons or rats (fig. 1).

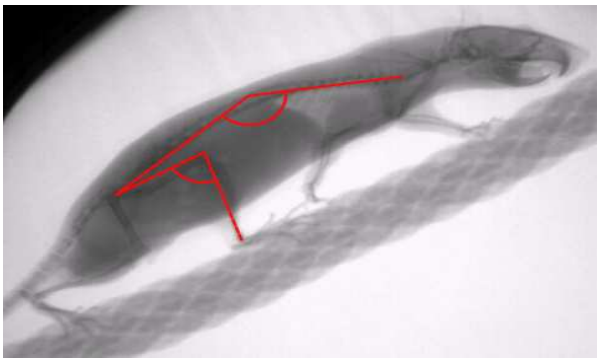


Figure 1: One frame of a highspeed–cineradography of a rat (Rattus norvegicus, 2.000 f/s)

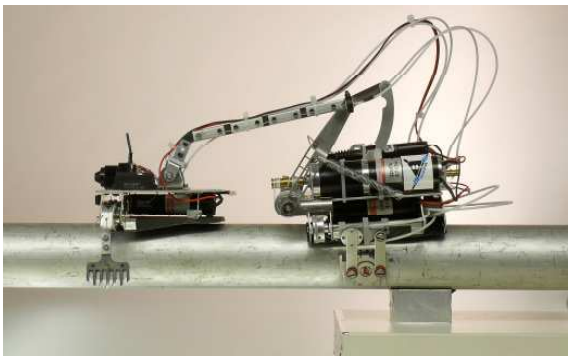


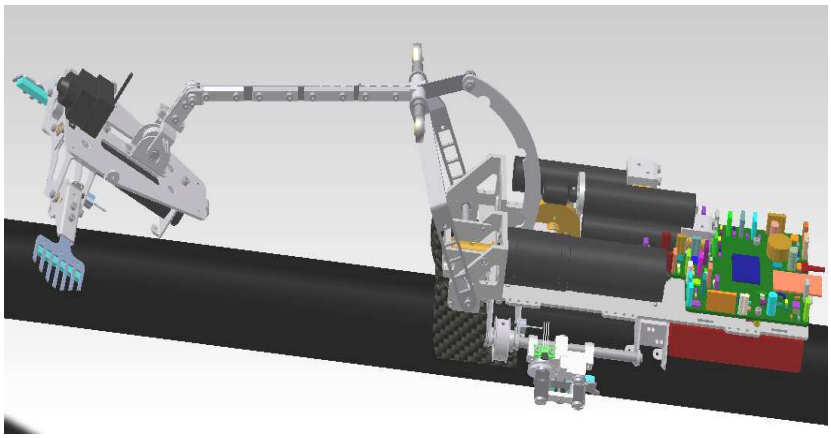
Figure 2: First prototype of the RatNic machine

TECHNICAL REALISATION

For the design of a climbing robot system RatNic engineers are inspired by functional principles of nature. A special feature is the realization of a flexible spine for the main climbing movement. So the robot has two “bodies”, which are connected by the flexible spine. Each body has a special clamping mechanism. The robot can grasp linear structures with a diameter of 1cm up to 7cm.

A further important point is to minimize the clamping force. By using special materials and structured elastic fingers we achieve high friction coefficients between μ=1,5 and μ=2.

For the movement of the complete system the robot has only 7 DC-motors. Integration of compliant mechanisms reduces the weight of the robot and the costs of control.
The mass of the robot RatNic including mechanics, actuators, sensors, electronic control and energy source amounts to approximately 1,3 kg. Current climbing systems have an overall mass from 3 kg up to 75 kg.



The electronic control of the robot RatNic is based of a low power Fujitsu processor 96FX series. For reducing the power consumption each sensor can be deactivated.

The data transfer to the observing and operating station runs via an 868 MHz wireless connection.

Figure 3: Advanced construction of RatNic with camera module and electronic control unit

Acknowledgement:
The underlying project was granted by BMBF/DLR („InspiRat“ Fkz 01RI0633).

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